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ABSTRACT

This thesis seeks to analyze the materials produced by the Project for an Energy Enriched Curriculum (PEEC). Specifically evaluated are the completeness and degree of bias characterizing the materials as an entity. In support of this end, examined are the nature and extent to which the materials treat future energy alternatives and the extent to which the materials satisfy criteria for effective energy education as expressed in the general literature of the field. An instrument was developed by the study to evaluate the PEEC materials. The study detected some variations in reading levels from those intended and detected slight but non-systematic biases in the energy future considerations. (BE)

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AN ANALYSIS AND EVALUATION OF THE NSTA ENERGY EDUCATION MATERIALS PRODUCED BY PROJECT PEEC

THESIS

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of
West Virginia University
in Partial Fulfillment of the Requirements for
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by

Warren James Kooi, B.S.

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INTROLUCTION

Over the past few years the world has been barraged with crises. The environmental crisis, the food crisis, and the population crisis have all been subject to many news stories and voluminous literature. Titles such as: Ecospasm, Diet for a Small Planet, and The Population Bomb, have delineated the crises in detail and in some cases offered "solutions" to the underlying problems. The problems, however, have yet to be solved and a solution in isolation is doubtful since they are all interrelated. Further, it is hypothesized that these interrelated problems must be confronted by the world's population in order to preserve world civilizations (Mesarovic & Pestel, 1974).

The crisis on which America is currently focusing its attention is the energy crisis. The dependence of the American people on energy became evident during the winter of 1973-1974, when a drop in U.S. petroleum supplies caused disruptions in transportation, food production, economic, political, and environmental systems. These disruptions continue today (Energy & Man's Environment Inc., 1976).

Since the energy problem affects all levels of American society it has become a major concern for government, industry, and individual citizens. The federal government has recently created a cabinet level Department of Energy. In the closing days of 1978 congress passed a National Energy Act, a series of five bills designed to "conserve energy, accelerate (the) shift to coal and reduce U.S. oil import needs" (Department of Energy, n.d., p. I,1). The industrial sector has begun to apply analysis and conservation measures in order to increase profits (Anderson, 1974), and citizen groups such as Citizens Energy Project and Center for Renewable Resources have become active in pursuing energy issues.

The methods of attack on the energy problem vary considerably; in some cases directly opposing each other. Most apparent is the "soft vs hard" philosophies on future energy development as exemplified by Lovins (1976). The differing philosophies become important because they are viewed as being "mutually exclusive" and as having "influence (over) the course of human civilization and all life on this planet" (Murray, 1977, p. 221).

The energy crisis is complex and very much related to other crises (U.S. House of Representatives, 1975), and therefore it is crucial that the nature of the energy situation be understood by the American people; especially if they are to have a voice in determining America's energy

future. Government, industry, and educational institutions are all in positions to provide energy information to the American people. Energy-related industries reach many people through advertisement and public relations, but "private interests of energy companies and the broader public interest do not always coincide" (Ford Foundation, 1974, p. 10).

The federal government has an active role in energy education. (a) The Department of Energy (DOE) and Office of Consumer Affairs publish informational literature on energy topics. (b) The Department of Health, Education, and Welfare (HEW) sponsors pilot and demonstration programs in energy education and publishes project information packages in the energy area. HEW also operates an Energy Education Action Center (EEAC) whose mission is to "promote all phases of energy education related activities on an interagency basis... (and) to assist educational clientele in implementing energy plans" (EEAC, 1978, p. 2). (c) The National Science Foundation provides funding for the development of prototype instructional materials and for researching alternative courses and curriculum materials (HEW, 1978). (d) The National Energy Act provides money for states to "develop and implement energy education activities in each participating state" (DOE, n.d., p. III, 4).

The federal government, however, is not primarily concerned with direct education. Instead their role has been one of leadership and support (Duggan, 1977). Duggan, a spokesman for the Educational Programs Division of the DOE, has advocated that the government should tread very cautiously in the area of values clarification. The impartiality of the government has already been questioned, both by past policies of the Energy Research and Development Administration (ERDA) (Pollock, 1977), and by the nature of the proposed budget of the DOE for 1980, which includes only eight percent of its funds for solar projects. (Sun Times, 1979).

Educational institutions are also active in the area of energy education. One such institution, The National Science Teachers Association (NSTA), "predominates among those (institutions) who are aware that energy education is essential" (Carey, 1976, p. 23). Although an organization of science teachers, the NSTA's emphasis in energy education is "strong into not science education but interdisciplinary education" (Fowler, 1977, p. 224). The NSTA is conducting a multi-year project called the Project for an Energy-Enriched Curriculum (PEEC), which began with the publication of an Energy-Environment/Source Book, Materials Guide, and Mini-Unit Guide in 1975.(Carey, 1976).

The next phase of the NSTA project was a teacher participation competition for the design of student activities

using energy themes. (Fowler, 1976a). The contest resulted in the publication of winning entries for distribution by ERDA. (Carey, 1977). The NSTA then published a set of fact sheets on alternative energy sources which was also distributed by ERDA.

The NSTA is now involved in the production of Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy under a contract with the DOE. It is the only nation-wide, federally-funded energy curriculum project currently being developed. These instructional units were developed during summer workshops by teachers and NSTA staff, and have been or are being field-tested by other teachers in the areas and grades for which the units were designed. The NSTA has developed twenty-four classroom units thus far, and is planning additional units to bring this total up to thirty or forty by the completion of the project. (Fowler, 1976c). The goal of this phase of the PEEC project is to produce energy/environment/economics (e/e/e) materials "covering all the e/e/e concepts necessary to prepare students for a productive and happy life in the new energy era" (Fowler, 1976c, p. 14).

Although the PEEC materials are designed and field tested by teachers, there is no evidence of an independent assessment of the units outside the classroom. The materials have not been evaluated as an entity and their completeness and lack of bias have not been documented. It

was this oversight that was directly addressed by this research.

Statement of the Problem

The instructional materials in energy education produced by the PEEC project of the NSTA represented the most comprehensive effort in this country to introduce energy concepts in the classroom. The materials were promoted and distributed nationwide by the NSTA and the Department of Energy, but there was no evidence that the PEEC materials had been evaluated as a whole outside of the NSTA organization. The problem of this study was therefore to assess and evaluate the content of the curriculum materials in Energy, the Environment, and the Economy that have been produced to date by the NSTA under the US DOE sponsorship for use in the pre-college classroom.

Purpose of the Study

The purposes of this study were threefold:

1. To analyze and categorize the content of the PEEC materials;
2. To determine the extent to which these materials satisfy the criteria for effective energy education materials as expressed by authors in this field, and;
3. To determine the nature and extent to which the materials examine future energy alternatives.

Need for the Study

The need for energy education has been widely and passionately expressed. The project director of the NSTA (Fowler, 1976) has stated that "it is both urgent and

appropriate that we deal with energy in the classroom" (p. 88). Fowler's note of urgency was echoed by Posthuma (1978) in his introduction to a National Education Association book of energy curriculum materials, where he stated that it was "extremely important that today's young people understand energy and all its implications. One might say that their lives depended on it" (p. 8). The need has been further delineated by Congressman E. Pattison (1978):

> The children now in school will likely see the exhaustion of our domestic supplies of petroleum and natural gas in their lives. As young adults they will be acquainted with frequent and increasingly severe shortages. We must prepare them to face these problems. (p. 31)

The complex nature of the energy problem was discussed by Duggan (1978) in a description of his views toward energy education. In order for students to assess energy issues and to determine future energy options, Duggan spoke of a need for "a depth of information and understanding seldom demanded before of the general public" (p. 7).

In response to the need for energy education many instructional materials have been developed. The Educational Resources Information Center (ERIC) system alone contained over eighty sources spanning the years 1969 through 1978.

Curriculum development, however, was not enough. In a document explaining its own curriculum development efforts in the field of energy, The Indiana Department of Public Instruction (1978) stressed evaluation as being as important

to energy curriculum projects as development and dissemination efforts. The report emphasized the need for systematic evaluations of the strengths and weaknesses of curriculum materials by both teachers and persons outside of the classroom.

The need for an evaluation system for energy materials was also expressed at a practitioners conference on energy education, sponsored by NSTA at the University of Maryland. This conference, composed of teachers and others involved in energy education, was mostly concerned with "describing and defining the present and desired future of energy education" (Energy & Education, 1979, p. 6). A working group at this conference which made recommendations for supportive resources for energy education called for the development of an evaluation system for these resources.

An examination of the preceeding eight years of Resources in Education and Dissertation Abstracts indicated that only two such evaluation systems existed. The first instrument, utilized in "A Survey of Precollege Energy Education Curricula at the State Level", by the Energy Institute of the University of Houston at Clear Lake City, consisted of a single-page, yes-or-no checklist which in no way categorized curriculum materials by topic or subject area (Jones, 1977). The second instrument, entitled "Criteria for Effective Energy Education", was a comprehensive work by the Learning Research and Development Center

of the University of Pittsburgh. It provided questions to evaluate energy programs, teachers, and curriculum materials, but did not contain a specific analytical instrument (Champagne, 1977).

The need for this study has been expressed more specifically in the October 1978 issue of Energy and Education, a newsletter produced by NSTA. An article entitled "PEEC's Progress" called for assistance in the area of energy education and the evaluation of e/e/e materials with these words:

> We need to hear from you (the readers) about your experience with the packets, as well as your suggestions for areas of importance that we have neglected. Most of all, over the next year we need to begin to receive suggestions of what we, and the people in the DOE should do to make sure that this small start in the direction of infusing energy/environment/economics topics into curriculum continues and grows. (p. 5)

Questions

The following questions were found to be inherent to this study:

1. Were the reading levels of the instructional materials consistent with the grade levels for which they were intended?

2. To what extent were the instructional materials comprehensive in their coverage of important energy content areas?

3. Were the instructional materials balanced in their treatment of controversial issues for future energy use?

4. To what extent were the instructional materials consistent with recommended strategies for teaching energy-related subject matter?

Assumptions

1. In the cases where only draft copies of the PEEC materials were available, those draft copies did not vary significantly from the finalized versions.

2. The units which were currently available were representative of the units to be produced in the future.

3. The PEEC materials were meant to be comprehensive in their treatment of energy-related topics.

Limitations

1. This study was limited to the investigation of documents, both primary and secondary, located in the libraries of West Virginia University and to original documents requested by the researcher.

2. The data used in the analysis was limited to those Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy which were produced by the NSTA and were available either from the NSTA or the DOE, sponsoring agent for the PEEC project.

3. The assessment of the PEEC materials did not attempt to determine cognitive or affective levels represented by the materials.

4. The analysis of the activities did not attempt to evaluate extended learning activities or other optional parts of the activities.

Procedure

This study was executed in accordance with the following procedure: (a) the literature in the field of energy education was reviewed; (b) an instrument for the evaluation of the PEEC materials was constructed. This instrument had as its base the viewpoints on effective energy education programs and materials which were expressed in the literature by authors in the field of energy education. These viewpoints were

were organized according to the questions of the study. (c) The PEEC materials were analyzed and evaluated with the use of the evaluation instrument; (d) the findings and conclusions of the study were reported; and (e) recommendations were made for improvement of the PEEC project.

Definitions

The following terms were used as categories for the evaluation instrument. They have been defined for use specifically within the context of the study.

Attitude: "Readiness or predisposition to respond in a predetermined way to some object" (Banks, 1973, p. 430).

Centralized: Electrical power generation system with large capacity ($\sim 10^8$ W or greater) from single or clustered generating stations (Lovins, 1977).

Conservation: Reduction in the amount of energy used by a conscious alteration of existing energy-use patterns (Lovins, 1977).

Decision making: The use of acquired knowledge to; (a) identify alternative courses of action, (b) predict their possible consequences, and (c) choose a course of action most consistant with the decision-makers values (Banks, 1973).

Depletable: An energy source which cannot be grown or replenished at a rate meaningful to man; includes fossil and nuclear fuels (Cook, 1976).

Economy, Society, and Politics: Connections between energy and present socio-cultural systems (Horvat, 1978).

Ecosystem Interactions: The process by which the natural ecosystem captures and uses energy; the environmental impact of energy recovery, production, and use (Allen & LeHart, 1976; Commoner, 1976; ETS, 1976).

Energy Education: The presentation of learning experiences for students to interpret the world around them and to make intelligent decisions concerning energy-related political, social, economic, and environmental issues (Energy & Education, October 1977, p. 1; April 1978, p. 1).

Food: The use of energy specifically within the food procuction system and the human body (Allen & LeHart, 1976; ETS, 1976).

Futures: The potential for future utilization of energy resources or a specific energy resource (Horvat, 1978; Shane, 1977).

Growth: Continued expansion of the U.S. energy production based on the assumption of increasing future energy needs (Nelkin & Fallows, 1977).

History: Energy recovery, production, and use in the past (Allen & LeHart, 1976).

Localization: The teaching of energy-related concepts as they relate specifically to the students' home or school communities (ETS, 1976; Shane, 1977).

Localized: Energy conversion system of small capacity (less than ~10^8 W) which is located near the point of end-use of the energy (Lovins, 1977).

Physical Laws: The theories, principles, and laws from the physical sciences which explain the nature of energy and the way that energy behaves (Allen & LeHart, 1976; Commoner, 1976).

Problem Solving: The stepwise process to determine solutions to specific problems through trial-and-error (Clark & Starr, 1976).

Renewable: An energy source which can be grown or replenished at a rate meaningful to man (Cook, 1976).

Strategies: Policies and procedures which are necessary for the implementation of energy futures (ETS, 1976; Shane, 1977).

Supplies: The nature and amount of energy which is currently available or recoverable using technologies which are presently available (ETS, 1976; Lovins, 1976).

Transformations, Use, and Efficiency: Processes by which energy is transformed in form through human actions, or evaluation of the efficiency of energy transformations, with the exception of transformations within the food production system or the human body (Commoner, 1976; Shane, 1977).

Value: "Type of belief...about how one ought or ought not to behave, or about some end-state of existance worth or not worth attaining" Rokeach, in Banks, 1973, p. 445).

REVIEW OF LITERATURE

The oil shortages during the winter of 1973-1974 brought an awareness of America's total dependence on energy, much as the publication of Rachael Carson's Silent Spring (1962) revealed man's environmental dependence a decade earlier. From that awareness came the realization that students should be exposed to energy topics in the classroom. Consequently, educators began searching for ways to introduce the energy theme into the public schools.

This review of literature was an attempt to examine the role of energy in the classroom. It was divided into four parts: (a) the opposing strategies related to America's energy future, (b) the goals of energy education, (c) the content areas of energy education, and (d) the teaching strategies most appropriate for energy topics and issues.

Opposing Strategies Related to America's Energy Future

> Humankind has come to a fork in the road. A choice must be made. Should we choose a nuclear future, or should we choose a future primarily based on solar energy? Should we continue to pursue almost unregulated expansion of energy...or should we undertake a carefully thought out energy policy which stresses such factors as long-term energy availability, environmental

> and social impact, and prudent usage? This decision is very important for it will influence the course of human civilization and all life on this planet. Primarily it is a choice between mutually exclusive energy strategies, a choice of means. (Murray and LaViolette, 1977, p. 221)

The preceeding quotation addressed a genuine problem facing America, for which the literature showed many differing opinions. The differences of opinion were categorized into three sets of opposing energy strategies: centralized vs localized control of energy production, conservation of energy resources vs continued expansion and development, and the utilization of renewable vs non-renewable resources for the future production of energy.

The most quoted and argued position on these policies was that of Lovins.* Lovins (1976) believed that the opposing strategies were mutually exclusive. In his essay, "Energy Strategy, the Road not Taken?", Lovins outlined two differing energy strategies and called them soft and hard paths. These paths characterized the three dichotomies mentioned above. Lovins justified the pursuit of the soft path which he defined as being "flexible, resilient, sustainable, and benign" (p. 77).

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*See Science, Letters to the Editor: 24 June, 1977; 28 April, 1978; 22 September, 1978; 22 December, 1978; and News & Comment, 27 May, 1977. See also U.S. Senate, Select Committee on Small Business and Committee on Insular Affairs. Alternative Longe-range Energy Strategies. US Government Printing Office, 1977.

In the Annual Review of Energy, Lovins (1978) explained the advantages of decentralized energy production. He outlined twelve advantages of small, localized production, including mass-producibility of equipment, decreased distribution losses, increased reliability, and decreased vulnerability to sabotage. According to Lovins, large-scale electrical production for the present and future could be met by hydro and wind power alone.

Maxey, (1977) in rebutting the Lovins argument against centralization, took the position that economies of scale were functional, especially in the areas of fuel purchasing and transport, the energy conversion process, and plant maintenance. Maxey stated that environmental and public health hazards and aesthetic impacts were also minimized in large-scale, centralized facilities.

Weinburg, writing in Toward an Acceptable Nuclear Future (1977), also argued in favor of the centralization of power facilities. He proposed a system of nuclear parks, clusters of nuclear reactors on the same site. Weinberg claimed that this system of siting and operation would help keep nuclear power a viable option for energy production.

Nelkin and Fallows (1978) discussed a potential problem of centralized nuclear power production. Focusing

on the nuclear debate currently raging in this country, they explained that one of the fears of large, centralized nuclear facilities was the potential for the development of an electro-facist state to protect the security of nuclear installations. Nelkin and Fallows also addressed the inadequate role of the voting public in the decision-making process when dealing with large-scale projects.

Meinel and Meinel (1977), researchers in the area of solar technologies, viewed small-scale energy production as inconvenient, unreliable, and costly. They stated that although renewable energy resources might first be used on a small scale, public utilities would be the most favorable means of utilization.

In the area of growth vs conservation, the arguments were mostly economic. While there was a consensus that energy conservation was necessary (Freeman, 1974, Maxey 1977, Weinberg, 1977, Whiting, 1978), there was debate over the extent to which conservation could have an overall positive effect.

Freeman (1974) perceived a need to slow the growth of America's energy use and argued for a balancing of America's energy budget. In outlining a possible plan for future energy use, Freeman called for intelligent austerity. Freeman predicted as necessary a shift in production of goods to energy-rich areas and an increased

emphasis on services in the U.S. Part of his plan also included the establishment of planned, energy-efficient communities. Inherent to the plan was a fundamental change in the values and economy of America.

When assessing America's future energy growth, the Energy Policy Project Staff of the Ford Foundation (1974) developed three scenarios. Their study, appropriately entitled A Time to Choose: America's Energy Future, examined energy growth under three sets of circumstances. In the historical growth scenario, the staff predicted a doubling of energy use in the U.S. by the year 2000. The project staff found this scenario possible, but commented that it would strain many systems. Further, they declared that policies necessary to make the historical growth scenario a reality were not desirable.

The project staff's second scenario, the technical fix scenario, was proposed to determine the effect of conservation practices and policies. The results of this scenario predicted energy levels of 66% over the base year 1973 by the year 2000, a 1.9% average annual increase. Only those conservation strategies that were currently available and economically viable were used in the predictions.

The third scenario was entitled zero energy growth. The project staff, in this scenario, actually predicted a

25% increase in energy use by 1985 and a leveling of the growth curve afterwards. In summary of this scenario, the project staff concluded:

> Energy growth can level out without devastating economic effects if it is done carefully, over a long enough period. Energy prices would have to be higher-but not prohibitively higher-than in other scenarios. Renewable energy sources could begin to make substantial contribution to energy requirements by the end of this century and could become major sources for fueling the next century. (p. 111)

Neither the technical fix nor the zero energy growth scenarios were perceived to have a negative impact on employment.

The effects of projected conservation efforts were examined in a recent report by the President's Council on Environmental Quality (1979). Their report, Good News About Energy, concluded that with modest conservation efforts the U.S. could pass the years 1977-2000 with only 25% growth in energy use. Determined efforts could bring that increase down to 10-15%. The council maintained that such conservation efforts would have a beneficial effect on both the economy and employment.

The relationship of energy consumption to employment and economic health was viewed differently by Safer (1977). He argued that energy growth was directly related to maintenance of employment levels. Safer maintained that

approximately 4% annual energy growth was a necessary part of an improved employment picture in the U.S. In viewing the relationship of energy to the economy, Safer asserted "increased energy intensity makes for increased labor productivity, and thus for gains in real income, which we call prosperity" (p. 18).

The belief that energy growth was tied to jobs and the economy was further examined by Nelkin and Fallows (1978). They asserted that concern over these issues was the reason for the defeat of the referenda in western states to limit the expansion of nuclear power.

Whiting (1978) saw conservation vs growth as an unresolved issue and concluded that too much of either would be harmful. Discussing the impacts of conservation efforts, he concluded:

> Too much capital flow to conservation now will lead to unemployment and inflation. Too little conservation now will lead to a panic at some future time leading to harsh emergency measures with much more disruptive impacts. (p. 199)

In the debate over renewable vs nonrenewable energy usage, the question was again, how much? Lovins (1976) postulated that renewable energy sources could supply nearly half of the U.S. energy needs by the year 2000. Lovins further argued that renewable energy sources could provide all of America's energy needs, electric

and otherwise, by the year 2025. Finally, Lovins claimed that the technologies necessary for such a switch were currently available or nearly so.

The Ford Foundation report (1974) in its most liberal estimate for the role of renewable energy sources, predicted that renewable energy would provide a maximum of 11% of America's energy needs by the year 2000. Prospects for the next century were said to be brighter.

In the report, Solar Energy in America's Future (1977), the Stanford Research Institute concluded that renewable energy sources could possibly provide more than 25% of the nation's energy needs by the year 2020. The executive summary of the report, in assessing the total long-term energy alternatives closed with this statement:

> If society does not move toward dependence on nuclear energy then there is only one other viable direction....The only alternative is a solar-dominated economy with moderate energy demands. Solar energy is not a cure-all for all our energy problems; but combined with a larger strategy that includes energy conservation, cascading, and some sacrifice of convenience, solar energy does offer the option of a society based upon a renewable source of energy. (p. xvii)

The Lawerence Berkeley and Livermore Laboratories (1978) jointly examined the role that renewable resources could play in California's future. This study, projected to the year 2025, assumed a doubling of population, tripling of economic activity, and a quadrupling price of energy, with no change in the amenities of life currently enjoyed by California's citizens. A conclusion of the study was that renewable energy with a decentralized distribution system could supply 86% of California's energy needs by the year 2020. The 14% shortfall would be supplied by liquid fuels from other sources. Technological innovations were dealt with conservatively, for the projection took into consideration only those technologies with demonstrated or nearly demonstrated engineering feasibilities.

A pessimistic attitude toward renewable energy sources was exemplified by Forbes (1977). His view was that renewable energy sources could provide at best 6% of the nation's energy needs by the year 2000. Forbes concluded that "energy supplies for several decades at least will thus have to come principally from fossil fuels and from nuclear fuels" (p. 34).

Murray and LaViolette's "choice of means" quoted earlier has been openly debated over the past five years. The issues of scale, growth, and resource base in

America's energy future were not resolved in the literature. This lack of consensus was one of the problems for educators as they attempted to define the desired future of energy education.

The Goals of Energy Education

"Opening our eyes is what the job is all about." This quote from Fowler's article in the Junior College Science Teacher (1977, p. 95) implied that before energy education could be made effective, people must begin to realize that the energy situation demanded attention and understanding. Duggan, (1977) speaking for the Department of Energy at a symposium on energy conservation education, also articulated the importance of becoming aware of the realities of the energy situation, and judged it a prerequisite for any changes in behaviors.

Duncan (1977) viewed the major goal of energy education to be a change agent for students' attitudes toward energy and energy conservation. He outlined six approaches for affecting attitudinal change which included role playing and behavior modification techniques. Attitude changes were also deemed important to Covert. In a 1976 article for Industrial Education, Covert expressed the thought that teachers had the responsibility for changing the attitudes of students toward energy consumption.

Boyer, in Energy Education: Teaching Alternatives (1978), further substantiated the need for a focus on perspectives and attitudes. When discussing the next century, Boyer claimed that the development of proper attitudes was critical in order for the world to survive.

In Mankind at the Turning Point, (1974) Mesarovic and Pestel viewed the change of attitudes, both individual and societal, as being necessary to solve the energy and other related crises. Further, they called for "drastic changes in the norm stratum...value system, and goals of man" (p.22). Mesarovic and Pestel felt these changes necessary to achieve balanced, differientiated growth and prevent the collapse of societal systems and eventually the entire world system.

Underlying these calls for attitude changes was the message that the proper attitude was one of conservationism, which Odum and Odum (1977) call ecosystem education. In an American Biology Teacher article entitled, "Energy Systems Education", they stressed the need to "place importance on our role in ecosystems, limiting our individual acquisitiveness and our demands as human populations" (p. 423). The conservation ethic to them was the philosophical viewpoint of kinship, brotherhood and sisterhood, with the earth.

In a summary statement concerning five regional

hearings on energy education sponsored by the Federal Energy Agency (now DOE), in 1976, the staff of the Education Testing Service (ETS) concluded that energy educators felt it imperative to change lifestyles to conserve energy. From the Atlanta hearing came this statement, which also dealt with attitudes:

> The first task at hand is to convince people that the continuous depletion of energy resources is producing a real crisis and that this implies definite changes for our society. (p. 13)

Fowler, however, in "Energy Education and the Wolf-Criers" (1976) warned against the overemphasis of conservation in an overall energy education program. In presenting his views on the goals of energy education, he outlined four distinct, behaviorally stated goals which he addressed to what he called the student-citizen. Within the framework of these goals he called for: an understanding of the science, technology, and the pervasiveness of energy as it related to today's society; the ability to make informed political decisions about energy options; the ability to "make personal life-style decisions which are consistent with energy realities" (p. 32); and an awareness of energy-oriented career opportunities.

Fowler further stressed the importance of understanding energy options at a conference entitled

Education Confronts the Energy Dilemma (1977). There, he underscored the inability to teach solutions to the energy problem. Instead, Fowler stated, the students should recognize the nature of the problem and be presented with current options, of which he specifically mentioned appropriate technologies.

The need to understand the present energy situation and the options available for the future was also the theme of an article by Duggan for Science and Children in 1978. In "Energy Education and the Three C's", Duggan's three C's were citizen, careers, and consumer. Similar in many respects to Fowler's, Duggan's goals were for: a knowledgeable voting public, with understanding of past perspectives, the present situation, and future options; students with skills necessary to gain employment in an energy related field or to choose a career with a realistic judgment on how energy would affect that career, and consumers with knowledge of energy efficiencies and energy conservation ethics and lifestyles.

Greenwald and Hann, writing in Man/Science/Technology (1977), expanded the goals of energy education beyond the classroom in an active sense. Calling for education to establish rather than follow society, they advocated the demonstration of energy alternatives to the public by

the educators themselves or through their students.

Whitehurst (1977), mentioned seven goals of energy education, three of which related to those of Greenwald and Hann. Whitehurst saw the necessity for teaching students to influence their parents, especially in the area of energy conservation. He also encouraged schools to set an example to the community on what could be done in the area of energy conservation. Other goals mentioned by Whitehurst were the teaching of interdependency among the nations of the world and the improvement of the students consciousness of lesser developed nations.

In order to achieve the goals of energy education, the consensus of the authors was that certain content areas needed addressing. Though, like the goals, the proposed content areas were diverse, common themes were present.

Energy Education Content Areas

Barry Commoner, in The Poverty of Power (1976), explained that three basic areas of understanding were necessary for a grasp of one's relationship with energy. The first area, the way in which the ecosystem captures energy, dealt with energy inputs to the world, both past and present, and the natural methods for energy storage. The second area, the use of energy by the production system, dealt with energy transformations and uses. Commoner's final theme was the way in which the economic

system governed what was done with the wealth generated by those transformations. He saw the science of thermodynamics as the key to these areas of understanding.

Thermodynamics, both the first and second laws, was also deemed important by the participants of a Practicioners Meeting on Energy Education sponsored by the NSTA. At this meeting, which was reported in the January 1979 Energy and Education, participants also chose conservation and efficiency, supply and demand, and decision making exercises as being important content areas in the study of energy.

Other authors have described more numerous content areas for study. The report from the ETS (1976) contained descriptions of numerous content areas for recommended study including: depletion and its relation to present energy sources; environmental impacts of energy recovery conversion and use; energy conservation; the relationship between energy and food; and alternative strategies for future energy use. Each of these areas was felt to be important in the study of energy.

In an attempt to simplify extensive listings of content areas, some authors such as Horvat (1978) called for a back to basics approach to energy education. Horvat emphasized six categories of study. Describing the

category energy connections, Horvat, like Commoner, emphasized the importance of examining the ecosystem and its relationship with energy, but went further than Commoner in describing the natural, societal, and political interactions of energy use. Horvat, again agreeing with Commoner, further stressed the importance of the second law of thermodynamics and its implications for coupling energy types with end use needs. Under the category, fossil fuels, Horvat stressed the additional need for energy education to explore other energy options.

Shane, in an address at the National Symposium on Energy Conservation Education in 1977, described a proposed energy program. The key concepts of that program were: the realities of present energy production and use, alternatives for the future use of energy, consequences of those alternatives, energy choices which had to be made both now and in the future, and strategies for implementation of those energy choices. Within the concepts of this program, Shane emphasized the role which people played in decision making as being important.

By far the longest list of content areas was listed in a Florida State University document, Implementing Energy Education in Florida's High Schools (1976). This list divided the major energy concepts into three categories. The first category, the universe of energy,

included such physics and earth science concepts as: work, potential and kinetic energy, light and solar radiation, machines and energy conversions, and the laws of thermodynamics. Category two, living systems and energy, dealt with energy relationships among biological organisms, food webs, energy pyramids, producer consumer and decomposer relationships, and photosynthesis and respiration. Energy and human use, as the third category, included thirteen concepts such as: energy history, recent growth trends in energy use, food and energy, and energy consumption patterns.

While not all authors made reference to the same content areas, a consensus was reached regarding many of the areas. Specific strategies were outlined for the effective transfer of energy concepts to students in the nation's schools.

Teaching Strategies for Energy Topics and Issues

In commenting on the place of fit for energy education in the modern school curriculum, Boyer (1978) wrote:

> This time I have high hopes that we can resist the fragmented approach.... They [the schools] will have to abandon the fragmented approach to knowledge and the shattered perspectives from which we examine our globe. They will begin to address themselves to the part of us that lives in a community and relates to other human beings.... The

> schools will...derive a curriculum to highlight and strengthen the linkages among ourselves and with our common future. (p. 8)

This theme of interdisciplinarity pervaded the writings on energy education. Fowler, writing in Science Teacher (1976b) and again in Junior College Science Teacher (1977b), saw the interdisciplinary nature of the energy issue as being an advantage for energy education and for education in general. "Education," Fowler commented, "is always strengthened when we show that the disciplines work together to solve problems". Further, Fowler called to "make energy education part of the entire curriculum" (1977a, p. 223).

Kellet, in an editorial for Energy and Education (1977), addressed this same issue using slightly different terms. Kellet emphasized the inability of the physical sciences to deal effectively with the energy situation. Although acknowledging the importance of an understanding of the physical sciences, Kellet explained that a grasp of the social sciences and "the arcane science of government" (p.1) were also necessary ingredients for effective energy education.

Stronger words were used by Champagne and Klopfer (1977). In "Criteria for Effective Energy Education,"

they wrote, "even superficial knowledge of the complexities of the energy dilemma requires knowledge of several disciplines - Physics, Biology, Sociology, Economics, and Political Science" (p. 16). Champagne and Klopfer stated that the implications of the energy problem for formal education were that traditional subject barriers had to be broken down to effectively accomodate energy education and that schools now had to have a "willingness to reorganize the usual compartmentalization of school subjects" (p. 18). Pattison (1978) also saw the need for interdisciplinarity. Pattison mentioned specific subject areas (history, economics, industrial arts, the sciences, and home economics) that should be incorporated into an interdisciplinary energy program. Pattison emphasized that the discipline of science could not handle energy education alone.

Horvat (1978), in agreement with Pattison, also perceived that an interdisciplinary effort was needed. Horvat wrote of yet another strategy that was inherent to energy education, infusion into the existing curriculum. Further, Horvat felt that there was a need to introduce energy-related concepts at all levels of the school curriculum.

Duggan (1978) also alluded to the pervasive nature of energy education. He recognized that the role of energy education should be broad, and stressed the

necessity of involving all grade levels in energy activities. Duggan also stated that energy education should involve all areas of the curriculum and not be restricted to the sciences and social sciences.

Other authors also agreed that various grade levels should be involved with energy education. The ETS document (1976), which summarized five regional hearings on energy education in our nation's schools, stated that the support of interdisciplinarity and integration was common to all regional hearings. At the Atlanta session, the danger of single exposure to energy issues was emphasized. Students, upon completion an isolated lesson on energy, might consider themselves "experts" without ever being exposed to the real complexities and interrelationships inherent to the energy situation.

Fowler, on three separate occasions (1976a, 1976b, 1977b), addressed the need for integration of energy concepts into the school curriculum. He set curriculum integration as the primary strategy for the implementation of energy education. Underscoring his point, Fowler wrote that integration should take prescedence over energy conservation as a goal. In an outline of raison-d' être for energy education, Fowler stated that each grade level should use energy concepts in the curriculum.

In addition to defining its place within the modern

school curriculum, some authors also described approaches or methodologies which they felt would be appropriate for the teaching of energy education. One such strategy proposed in the ETS document (1976) was the problem solving/decision making approach. Since the energy problem was seen to have bearing on the students' everyday life, present and future, it was felt that individual students should have practice in making decisions. The same theme was expressed at the Energy Practitioners Meeting sponsored by the NSTA (Energy education practitioners, 1979). One of the general recommendations was that curriculum units emphasizing careers, technical applications, and hands-on problem solving should be developed. Horvat (1978) agreed, saying "responsible energy decision-making must be a high-priority goal" (p.3).

Attitudes and values, believed to influence the students' decision-making process, were also seen as being an integral part of the study of energy. Horvat's back to basics approach included, as its first component, attitudes and values. Commenting that the energy crisis had no technological solutions, Horvat saw a need for students to overcome a strong technological bias and to become aware of the human factors inherent to the energy problem.

Ortleib, in a guest editorial for Energy and Education (1978), stated that students were not aware that people's attitudes and values played an important part in the present energy situation. Calling attitudes and values "human factors", Ortleib wrote "students have perhaps been made aware of the energy crisis and some of the technological aspects of it, but we have not helped to give them an in-depth feeling for the humanistic factors involved" (p. 1).

Boyer (1978), in Energy Education: Teaching Alternatives, alluded to the imperative nature of teaching attitudes and values:

> The energy crisis we now face will require not only new technology, but new values and new attitudes as well. We must change our habits of consumption. We must approach self-indulgence with a new perspective - an understanding that we are members of a human community with a common fate. All of this is closely tied to our nation's schools and colleges. (p.10)

The Public Energy Education Task Force (Issues for Discussion, draft report, 1979) also took a stand on the teaching of attitudes and values. The group members, who were brought together by the Department of Energy, emphasized that "education should not be directed to the beliefs, attitudes, or actions that individuals should adopt, even in such generally accepted areas as energy

conservation" (p. 4). The members further explained that the job of education was not to propagandize or indoctrinate, but rather to increase the understanding of energy choices so that people could make their own decisions based on accurate knowledge.

The way in which these energy choices were to be presented was deemed important by several authors. Samson (1977) saw the need for unbiased materials in the field of energy education. Samson further observed that there was an acute shortage of such instructional materials. The participants of the Energy Education Practicioners meeting also made clear their belief in the importance of presenting materials in an unbiased way. As reported in the January, 1979, Energy and Education, the practicioners stated that materials developed for the teaching of energy concepts should be balanced in point of view and not slanted toward any particular energy option or lifestyle choice. Horvat (1978) also made this point as he warned against the use of propaganda disguised as factual material. Horvat advocated the presentation of all sides to every issue.

Another recommendation from the practicioners conference (1979) was to make energy education materials regionally adaptable and suited to local needs.

This concept was voiced by Shane two years earlier. Shane (1977), in discussing energy conservation, saw the necessity of providing opportunities to serve the community and felt that conservation education would not have lasting impact on students without such opportunities. The ETS document (1976) also contained statements which mentioned the important nature of community involvement. The report, however, also contained statements which warned that the national and international implications of the energy situation should not lose importance as a result of such localization.

Summary

The belief that America could determine its energy future was shared by almost all the authors investigated, but viewpoints differed on the optimal nature of that future and on how that future should be determined. Aspects of possible futures on which arguements were focused were: (1) the optimal scale for the design of future energy production and distribution networks, (2) the magnitude of future energy needs, and (3) the nature of the resources that should be utilized to meet those future needs. Some of the authors believed that America could attain a future using renewable resources at a non-increasing rate. Other

authors saw the need and advantage of continued growth and a future based on nuclear energy as a replacement for fossil fuels. There was also a lack of consensus about the scale of future energy production, even among those authors who advocated renewable energy sources.

Most authors agreed, however, that students should become aware of the various energy production options. This awareness was viewed as a key goal for energy education, both in the area of future alternatives and in the understanding of our present energy situation. Other goals perceived as being important were the examination of attitudes, values, and lifestyles, especially in the area of energy conservation, and the expansion of energy education to areas outside of the classroom.

In order to achieve these goals the authors generally agreed that it was necessary to study a variety of energy-related concepts. The study of physical laws and principles was perceived as basic to energy education, with special emphasis placed on the laws of thermodynamics. The 2nd law (the entropy law) was seen to be especially crucial. Also regarded as basic to energy education was the knowledge of fundamental ecological and environmental princilpes.

In order to appreciate the present energy situation, a historical perspective of energy use and development was felt to be necessary, as well as background knowledge of present energy sources and their current level of abundance. The process of transforming these energy sources from one energy form to another, including those involved in the human food/energy chain, was seen as an important concept by some authors.

Other authors viewed the interconnections of energy with the economic, societal, and political systems as being important content areas for the study of energy in the classroom. Conservation and end-use efficiencies were perceived as being important, as were future alternatives and the strategies needed to accomplish those alternatives. Since the literature showed that there was disagreement over future alternatives for energy usage, some authors felt that it was important for teaching materials and strategies to be unbiased, presenting a balanced perspective of controversial issues.

An interdisciplinary approach was the most widely recommended strategy for teaching energy concepts. It was generally agreed that all disciplines within the school curriculum should become involved with energy education. Energy concepts were thought to be applicable

to all grade levels. An infusion of energy education into all grade levels was deemed important.

Other highly regarded teaching strategies for energy education included problem-solving and decision-making exercises and the examination of attitudes and values. In order to have maximum impact, it was perceived that energy education should be readily applicable to real life situations, and that materials and methods should be adaptable or applicable to local situations.

METHODOLOGY

This research was conducted using a methodology which was composed of six basic processes: (a) review of the literature, (b) construction of the instrument, (c) determination of the reliability of the instrument, (d) collection of the data, (e) analysis of the data, and (f) determination of the conclusions and recommendations. This chapter deals with a detailed explaination of these processes.

Review of the Literature

The literature in the field of energy education was first examined in an attempt to locate an instrument which would be suitable for the evaluation of the PEEC materials. An examination of the past six years of Dissertation Abstracts, Resources in Education, The Education Index, and Current Index to Journals in Education, as well as energy-related books failed to locate such an instrument.

Since the review of literature failed to reveal a suitable evaluation instrument, energy education literature was then examined in more detail in order to determine the characteristics of a suitable instrument. Specific authors who wrote about energy education expressed opinions about the optimal nature of energy

education. These opinions were extrapolated from the literature, then collated so that areas of consensus could be determined. These areas of consensus formed the basis for the evaluation instrument (see Figure 1 for outline of instrument construction process).

One area of consensus among many authors was that controversial energy issues should be examined in the classroom. Writings of authors who expressed opinions on controversial energy issues were reviewed in order to determine the nature of these issues. The opposing viewpoints related to the energy issues were determined from the literature, and these viewpoints formed the basis for that specific part of the evaluation instrument.

Construction of the Evaluation Instrument

Choosing and Defining Categories

Once the areas of consensus and division concerning energy education had been identified, it was necessary to group these specific areas into categories. The categories were developed to be as self-expainatory as possible. The categories which were developed were: (a) grade levels, (b) subject areas, (c) content areas, (d) controversial issues, and (e) teaching strategies.

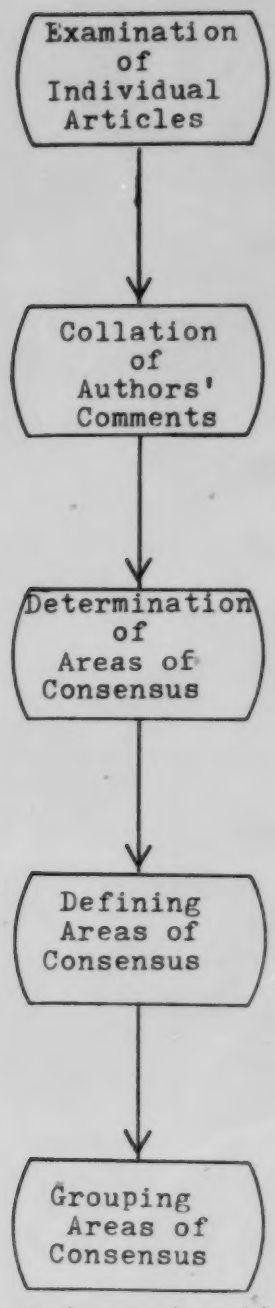
Examination of Individual Articles
Collation of Authors' Comments
Determination of Areas of Consensus
Defining Areas of Consensus
Grouping Areas of Consensus

Figure 1. Instrument construction process.

Grade levels The review of literature revealed a consensus that energy education should be dealt with at all grade levels within the school system. Since the individual PEEC packets were labelled with specific grade levels, the determination which needed to be made was whether or not these materials were appropriate for the specified grade levels. This determination was made using the Fry Readability Scale (Fry, 1975). The recording unit in the grade level analysis was chosen to be the instructional packet (see Appendix A for packet descriptions).

Subject area The authors suggested that multi-disciplinarity was necessary for any energy education program that was designed to be at all comprehensive. To assess the extent to which the PEEC materials satisfied this criterion, the subject area category was developed. The specific subject areas chosen were as described by Trump & Miller (1979), with the exception of the subcategory, unified arts. Trump & Miller had described these areas separately as fine arts, home economics, and industrial arts. The specific subject areas chosen were: (a) business and distributive education, (b) career education, (c) english language arts, (d) foreign languages, (e) mathematics, (f) physical education, health, and safety education, (g) science, (h) social studies, (i) unified arts, and

(j) vocational and technical education. Since the subject areas and other categories varied within the instructional packets, the student activity was selected as the recording unit for this and subsequent categories.

Content areas Some authors examined in the review of literature mentioned specific content areas that energy education should address. Since different words were used to express the same content areas in some cases, these content areas were grouped into categories. The categories were: (a) physical laws, (b) ecosystem interactions, (c) history, (d) supplies, (e) transformations, use, and efficiency, (f) food, (g) economy, society, and politics, (h) conservation, (i) futures, and (j) strategies. Definitions of the content areas were also listed in the Introductory chapter.

Controversial issues Some authors examined in the review of literature indicated that controversial energy issues should be discussed in the classroom. These authors further indicated that the treatment of these issues should be balanced. An examination of authors' viewpoints on energy alternatives for the future revealed three basic issues: (a) scale of energy production, (b) energy use levels, and (c) type of resource base to be used for energy production. The

opposing viewpoints for each of these issues were identified from the literature as being: (a) centralized vs decentralized, (b) continued growth vs conservation, and (c) renewable vs depletable. Definitions for these terms were described in the introductory chapter.

Since quantification of data was necessary for the determination of balance, enumeration units for the controversial issues were set up. These enumeration units were: (a) space (number of pages devoted to the examination of each viewpoint), (b) time (number of class periods devoted to the examination of each viewpoint), and (c) presence-absence (frequency of occurrence of activities examining each viewpoint).

Teaching strategies There was some consensus concerning three specific teaching strategies which were believed to be particularly important in the field of energy education. These strategies were identified as: (a) the use of problem solving and decision making approaches, (b) the application of energy education to the students' local situations, and (c) the examination of students' attitudes and values as they related to the energy situation. Definitions for key terms in this category were also described in the Introduction.

Construction of the Evaluation Matrices

A separate matrix was developed for each of the

two different recording units to be used. In the unit-by unit analysis of reading levels, a readability analysis matrix was constructed for the recording of data and analysis of reading levels. This matrix contained columns for: (a) unit number, (b) pages analyzed, (c) number of sentences per 100 word passage, (d) number of syllables per 100 word passage, and (e) reading level specified in the packet. The matrix also contained an additional column for the recording of grade levels calculated from the recorded data (see Appendix B).

Since the recording unit for all other categories was the activity, an activity evaluation matrix was constructed to record the data gathered from these other categories. Each category was divided into its subcategories and squares were constructed to record the presence-absence of each subcategory for each activity. The squares constructed in the controversial issues category were divided diagonally to allow for the recording of the additional enumeration units of space and time (see Appendix C).

Testing of the Instrument for Reliability

The reliability of the activity evaluation matrix was determined by interobserver agreement in analyses of the sample unit. One of the PEEC units was selected at

random (Unit 4). This unit was then analyzed with the activity evaluation matrix by the researcher and two other persons with experience in energy education. The data collected by this process were then evaluated for percent agreement among the three analysts. The percent agreement was determined by dividing the total number of responses which were in agreement by the total number of agreements plus disagreements (Hack, Cormier, & Bounds, 1974, p. 335). The average inter-observer agreement was thereby determined to be 86 percent, which was within the acceptable bounds suggested by Hack, Cormier, and Bounds.

Collection of the Data

Readability

The data for the determination of readability were collected using a procedure outlined in Figure 3. All pages were analyzed using the first 100 words that appeared in sentence form. The readability analysis matrix was used for recording the data (see Appendix B).

Other Categories

The data for all other categories were collected by category on a unit-by-unit basis. The activity evaluation matrix was used to record the data (see Appendix C).

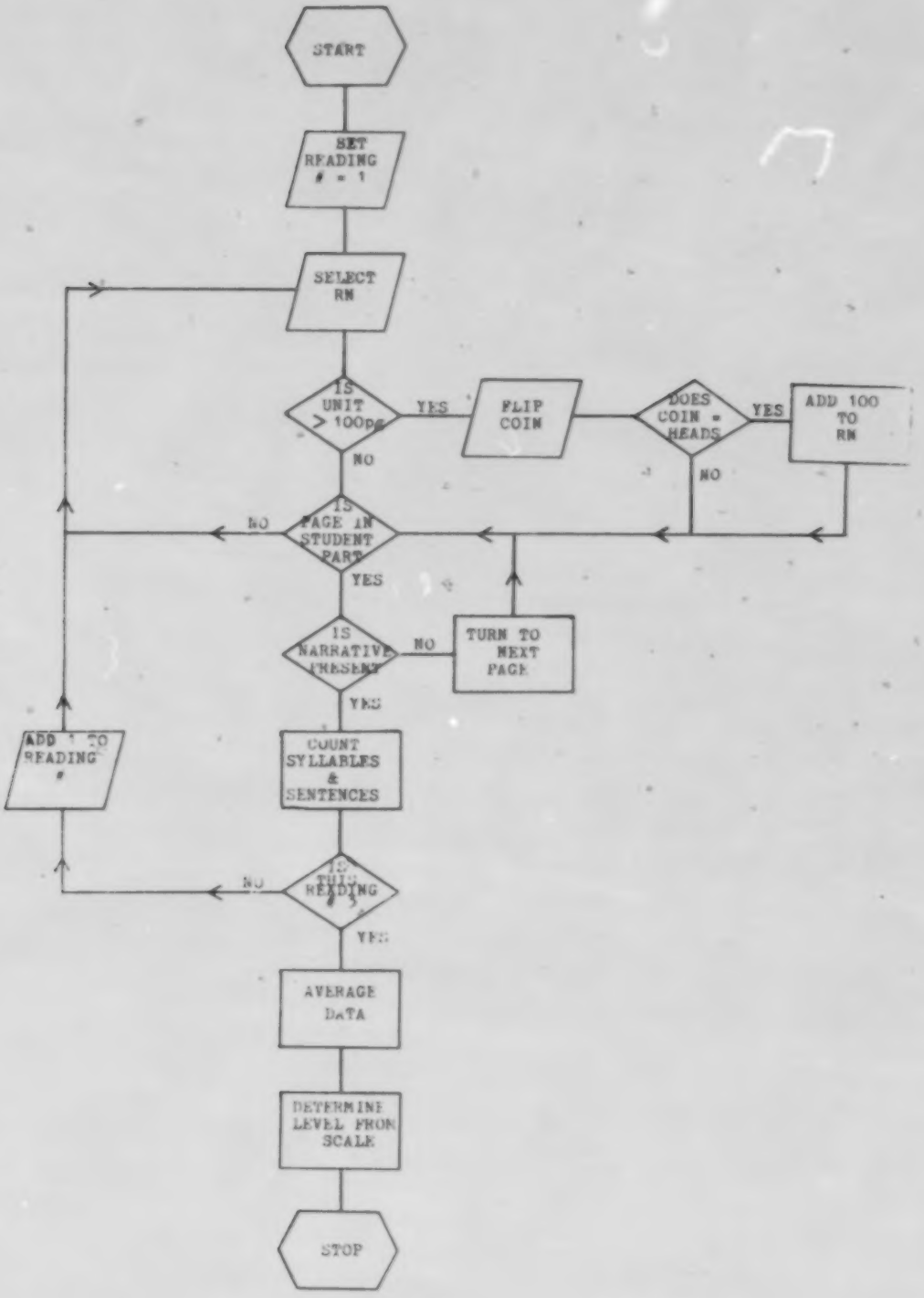

Figure 3 Procedure for analysis of readability.

Subject area Subject areas were recorded as stated in the teachers' section of the packets. No subject area was stated or recorded for packets directed toward grades one, two, or three. In other cases where the subject area was not specified, the areas were inferred from the contents of the activities and recorded in parentheses.

Content areas Content areas for each activity were recorded on the matrix after assessment of the individual lessons. One, two, or three subcategories were recorded based upon the definitions contained in the introduction. In rare cases where no energy content area was addressed in the lesson, none was recorded.

Controversial issues Two numbers were recorded whenever controversial issues for future energy use were addressed in the activities. The subcategories were determined according to the definitions listed in the Introductory chapter. Time and space enumerations were then determined and recorded. Time units in days were recorded in the upper sections of the blocks. The larger figure was recorded when variable times were given for activities. A plus sign (+) was reported when no time limit was specified. The pages of material dealing with controversial issues were recorded in the lower section of the blocks. Pages containing teacher introductions

were not counted.Partial pages were recorded as whole numbers.

Strategies The presence-absence of teaching strategies which were deemed important to energy education was recorded for each activity in each unit. Definitions used in determining the nature of these strategies were listed in the Introductory chapter.

Analysis of the Data

After the data had been recorded on the matrices it was collated by unit and by category in order to identify significant patterns. Rank order tables were constructed and frequency distribution histograms were completed where appropriate. Tables were constructed for the data collected on controversial issues. These tables were used to compare the amount of exposure given to the opposing issues in each category.

Determination of Conclusions and Recommendations

The conclusions of the study were made in reference to the research questions found in Chapter 1. Each question was addressed individually and was answered with reference to the analyzed data. Following the reporting of conclusions, a list of recommendations based on those conclusions was presented. These recommendations were made for the improvement of the PE&C materials and for further implementation of the

PEEC project. Recommendations were also made for improvement of the evaluation instrument and for further study. Supplementary recommendations were also made based on observations which were extraneous to the focus of the study.

DATA AND ANALYSIS

A total of 21 PEEC units were analyzed in the study. Three units, numbers 15, 16, and 26 were unavailable and were not included in the research (see Appendix A for titles and descriptions of the units). Of these 21 units, the first thirteen were in final or second draft form and obtained from the DOE Technical Information Center in Oak Ridge, Tennessee. The other eight units were rough drafts obtained directly from the NSTA offices in Washington, DC. The PEEC units contained a total of 134 activities dealing with energy education. The number of activities contained in individual units ranged from a minimum of three in unit ten to a maximum of thirteen in unit five. Unit-by-unit summaries of the data collected from these units are contained in Appendix D.

The data were collected by unit for the readability analysis. The other categories were analyzed for each activity. Unit summaries of the diversity in category coverage are shown in Table 1.

Reading Levels

The reading levels determined by analysis of the PEEC units ranged from third grade to college level

Table 1

Number of Subcategories Found in Individual PEEC Units

Unit	Subject Areas	Content Areas	Controversial Viewpoints	Teaching Strategies
1	3	3	0	1
2	6	4	2	2
3	2	4	0	1
4	4	5	0	3
5	NA	6	0	2
6	NA	6	1	2
7	NA	4	0	2
8	3	7	0	0
9	3	5	1	1
10	3	5	0	1
11	4	6	0	3
12	2	3	0	0
13	1	3	0	0
16	2	1	1	2
18	2	6	5	1
19	4	7	1	2
20	1	6	1	2
22	2	6	1	3
23	1	6	6	2
24	3	5	3	2
25	2	4	6	1

as determined by the Fry Readability Scale (1975). Table 2 contains a unit-by-unit breakdown of the reading levels that were calculated in the study, as well as a breakdown of the grade levels for which the units were designed.

The PEEC units represented the whole spectrum of pre-college education from grades one through twelve. There was some difference, however, in the number of units prepared for the specific grade levels. Most of the units were intended for use in the secondary schools (see Figure 3).

The determination of reading levels from the readability scale showed representation of all levels

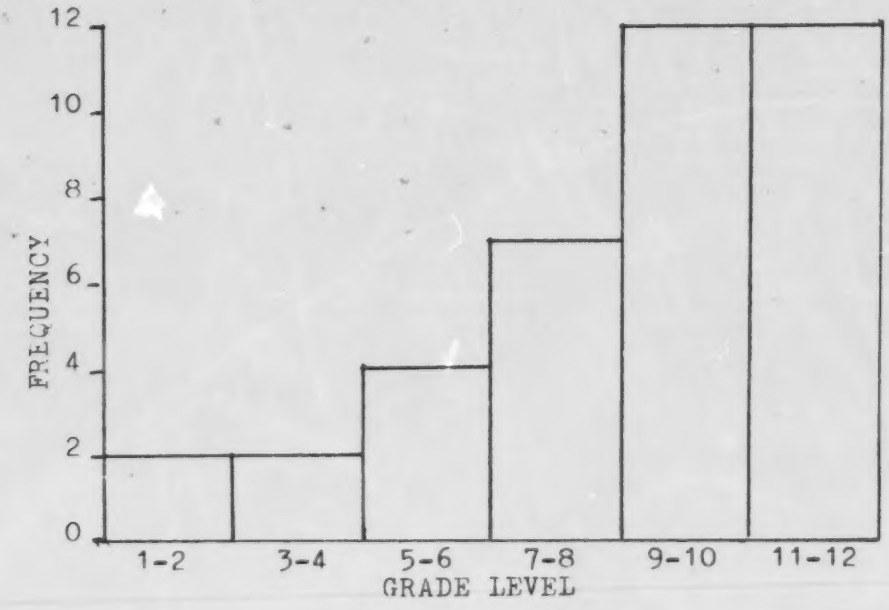

Figure 3. Frequency distribution of intended grade levels in PEEC units.

Table 2

Reading Levels of the PEEC units

Unit	Level Calculated	Level Intended
1	8	9,10,11
2	12	10,11,12
3	8	8,9
4	college	8,9
5	NA	2
6	NA	1
7	3	3
8	7	8,9
9	12	11,12
10	5	8,9
11	7	4,5
12	3	6,7
13	8	9,10,11
16	college	10,11,12
18	8	11,12
19	5	6,7,8
20	college	9,10,11,12
22	7	6,7,8
23	college	10,11,12
24	10	9,10,11,12
25	no level available	10,11,12

(See Appendix E for data relating to this table).

also. Reading levels ranged from the third grade to the college level. The first and second grade packets contained no student reading material. Figure 4 shows the frequency of reading levels determined from the study. It can bee seen from the figure that the most frequently encountered reading level was that of the junior high school.

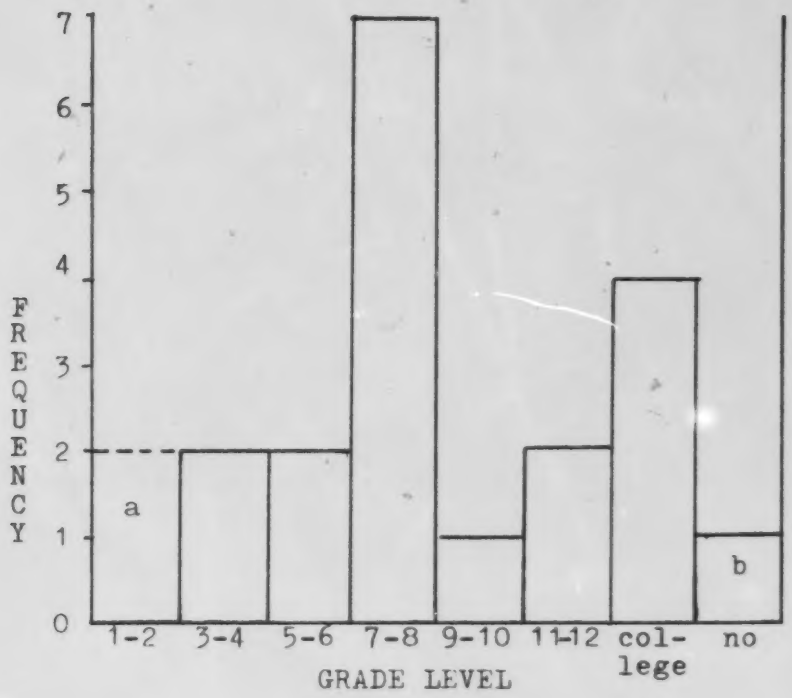

Figure 4. Frequency distribution of grade levels as determined by Fry Readability analysis of PEEC units.

[a]no reading material was contained in these units.

[b]this unit did not fall into any reading level category.

The reading levels calculated for the PEEC units were above, below, and at the same level as the grade levels for which the materials were intended. Deviation from the specified grade levels was encountered in twelve of the eighteen units that were analyzed. The deviations ranged from three grade levels below the specified grade level to four grade levels above the year specified in the unit (see Figure 5).

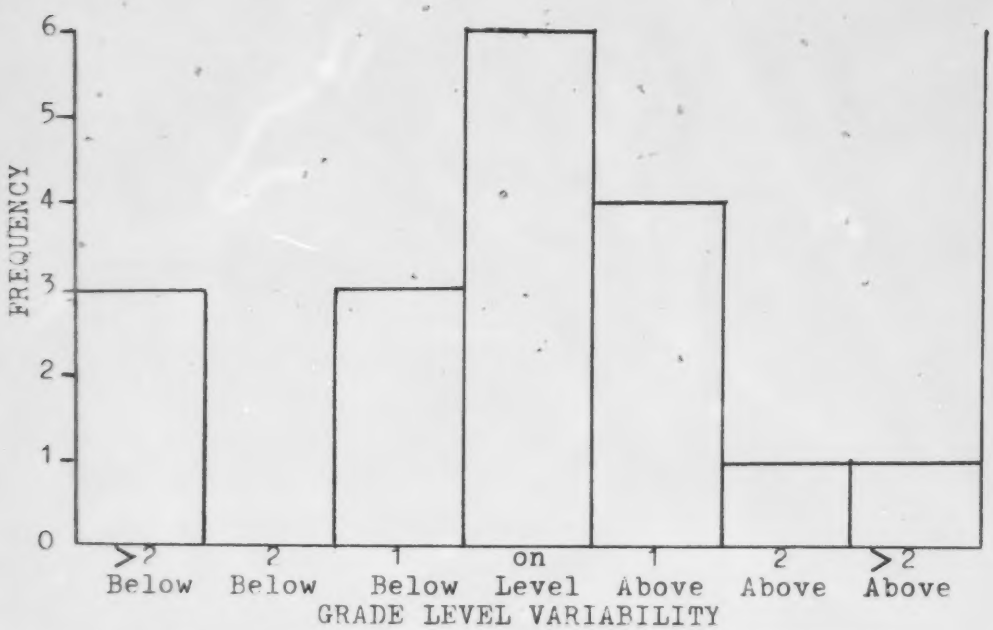

Figure 5. Frequency of variance from intended reading level of PEEC units.

Subject Areas

Examination of the data indicated that the PEEC units contained activities which were applicable to six of the ten determined subject areas. The areas of: business and distributive education; foreign language; physical education, health, and safety education; and vocational and technical education were not represented. Science and social studies were the most represented subject areas both in terms of total activities and number of units related to these subjects (see Tables 3 and 4). Individual units contained activities pertaining to as many as six separate subject areas (see Table 1).

Table 3
Rank Ordering of Subject Areas by Frequency of Activities

Rank	Subject Area	# Activities
1	Science	71
2	Social Studies	62
3	Mathematics	12
4	Unified Arts	6
5	Career Development	2
6	English Language Arts	1
8.5	All Others	0

Table 4
Rank Ordering of Subject Areas by Occurrence in Units

Rank	Subject Area	# Units
1.5	Science	15
1.5	Social Studies	15
3	Mathematics	6
4	Unified Arts	3
5.5	Career Development	1
5.5	English Language Arts	1
8.5	All Others	0

Content Areas

All energy content areas were represented in the PEEC units, some more so than others. The greatest number of units addressed transformations, use, and efficiency, while energy strategies as a content area was represented least (see Table 5). A unit-by-unit analysis of energy content areas revealed that transformations, use, and efficiency was also the most representative content area, while the topic of energy and food was present in the least number of units (see Table 6). Individual units contained activities addressing from two to seven different content areas (see Table 1).

Table 5
Rank Ordering of Content Areas by Frequency of Activities

Rank	Content Area	# Activities
1	Transformations, Use, & Effeciency	56
2	Economy, Society, and Politics	46
3	Futures	26
4.5	Ecosystems	21
4.5	Food	21
6	Physical Laws	19
7	Conservation	17
8	Supplies	15
9	History	13
10	Strategies	10

Table 6
Rank Ordering of Content Areas by Occurrence in Units

Rank	Content Area	# Units
1.5	Trans., Use, & Efficiency	17
1.5	Economics, Soc., & Politics	17
3	Futures	13
4	Ecosystems	10
5.5	Supplies	9
5.5	Conservation	9
8	Physical Laws	8
8	History	8
8	Strategies	8
10	Food	7

Controversial Issues

All three major controversial issues were addressed in the PEEC units at least once. Opposing viewpoints were not always presented in the same unit, but all six viewpoints were contained somewhere within the 21 units. Units 23 and 25 presented each viewpoint for all three energy issues, while unit 24 presented five of the six possible viewpoints. Unit-by-unit summaries of the coverage of these viewpoints are contained in Table 1. Tables 7, 8, and 9 present breakdowns of each controversial issue by viewpoint and amount of coverage in the PEEC units as a whole. In some cases both viewpoints were presented within the same activity.

Table 7

Balance in Treatment of the Issue of Scale of Production

Enumeration Unit	Centralized	Localized
Activities	6	6
Days	10+	9+
Pages	72	37

Table 8

Balance in Treatment of the Issue of Energy Use Level

Enumeration Unit	Growth	Conservation
Activities	2	5
Days	1+	10+
Pages	11	28

Table 9

Balance in Treatment of the Issue of Resource Base

Enumeration Unit	Depletable	Renewable
Activities	10	13
Days	21+	17+
Pages	81	104

Teaching Strategies

The three teaching strategies that were indicated as being important to energy education were all represented in the PEEC units. Table 10 presents the breakdown in the number of activities that contain the three teaching strategies. Problem solving/decision making and localization of lessons were nearly equal in amounts of presentation, while the examination of attitudes and values was a less evident teaching strategy. Over half of the units contained activities

which made use of the problem solving/decision making approach (see Table 11).

Table 10
Rank Ordering of Teaching Strategies by Frequency of Activities

Rank	Teaching Strategy	# Activities
1	Problem Solving/ Decision Making	24
2	Localization of Lessons	23
3	Examination of Attitudes and Values	7

Table 11
Rank Order of Teaching Strategies by Occurrence in Units

Rank	Teaching Strategy	# Units
1	Problem Solving/ Decision Making	14
2	Localization of Lessons	10
3	Examination of Attitudes and Values	7

FINDINGS AND CONCLUSIONS

The analysis of the 21 units of the NSTA PEEC project was completed in order to answer the research questions that were stated in the Introductory chapter. The research questions were:

1. Were the reading levels of the instructional materials consistent with the grade levels for which they were intended?

2. To what extent were the instructional materials comprehensive in their coverage of important energy content areas?

3. Were the instructional materials balanced in their treatment of controversial issues for future energy use?

4. To what extent were the instructional materials consistent with recommended strategies for teaching energy-related subject matter?

Each research question was examined and answered individually on the basis of the collected data. After examination and analysis of the data the following findings and conclusions were determined.

Question 1

Were the reading levels of the instructional materials consistent with the grade levels for which they were intended? The analysis of the data relating to reading levels of the PEEC units indicated that only one-third of those units were consistent with their intended levels. One-third of those units had reading levels above those specified, and another third were below grade level in reading difficulty. Variations from designed grade levels were as much as four grades removed from those expected. Unit four, which was designed for grades eight and nine, contained college level reading material. In two cases the reading levels were three grades below those for which the units were designed. Unit twelve, designed for the sixth and seventh grades, had a third grade reading level, and unit eighteen, which had been designed for grades eleven and twelve, contained eighth grade level reading materials. It was concluded that the effectiveness of the PEEC materials was reduced due to the variability in the reading levels of the units. One third of the units could be expected to be only partially useful in the classroom due to the difficulty of the reading material. Lack of interest could also result from other units being overly simplistic for their intended audiences.

Question 2

To what extent were the instructional materials comprehensive in their coverage of important energy content areas? All energy content areas identified as important from the review of literature were covered in the instructional units. The two broad areas of transformations, use and effeciency and economy, society, and politics were covered in nearly twice as many activities as other content areas.

Three content areas on which authors placed high importance were not extensively covered in the instructional units. The examination of physical laws relating to energy was covered in only twenty of the 137 activities and ranked sixth in relation to the other content areas in terms of exposure in activities (see Table 5). Energy conservation, a content area highly stressed in the literature, was addressed in only seventeen activities and ranked seventh in relation to the other areas. These two content areas of physical laws and conservation were also ranked low in terms of exposure in different units (see Table 6). Energy use in the future was a content area contained in 26 activities. The content area of strategies for implementing those futures, however, was addressed only ten times.

Another energy content area that was not emphasized was energy supplies. Fifteen activities within nine

of the PEEC units referred to the energy supply content area. Much of the emphasis within these activities was placed upon coal supplies. The treatment of controversial issues in the PEEC materials was limited in the first thirteen units (see Table 1). However, the rest of the units analyzed all contained presentations of these issues. Units 23 and 25 presented both viewpoints for each of the three issues that had been identified.

It was concluded that, while all energy education content areas were addressed in the PEEC activities, more emphasis was placed on some areas than others. Three areas in particular which were important to the authors reviewed received insufficient coverage. Although there was a caution in the literature against overemphasis on conservation in energy education, not enough emphasis was placed on conservation in these materials. Physical laws relating to energy use and and strategies for future energy use were also underemphasized.

Most of the activities pertaining to the content areas of strategies and futures were found in the draft units (numbers 16-25), and most activities dealing with controversial issues were also found in these units. It was therefore concluded that there was a trend

in the PEEC project toward increased coverage of these energy content areas.

Question 3

Were the instructional materials balanced in the treatment of controversial issues for future energy use? The issue of scale of production was examined in in six activities within four PEEC units. The two opposing viewpoints, centralization and localization, were presented equally in terms of numbers of activities and were allotted nearly equal exposure in terms of time. The number of student pages devoted to centralized production was nearly double that of localized production (see Table 7). It was concluded that both sides of the production scale issue were dealt with in the PEEC units. More student material was presented which emphasized centralized energy production. Since the opposing viewpoints on the scale of production were often presented within the same activity, the lack of balance in amount of student material led to the conclusion that the PEEC materials contained some bias toward large-scale energy production systems.

The issue of future energy use levels did not receive as extensive coverage as the scale of production issue. The presence of the conservation point of view was consistantly more evident than the opposing viewpoint of sustained energy growth. The

level of exposure of the conservation point of view was more than double that of growth for enery enumeration unit that was measured. Time units varied by a factor of ten (see Table 8). It was concluded that the conservation perspective of the energy growth issue was the predominant viewpoint expressed by the PEEC materials.

The resource base issue was the most frequently appearing energy issue in the PEEC materials. More activities, days, and pages of student material were devoted to this issue than to the other two issues of energy use levels and scale of production. While the amount of time spent on discussion of depletable resources was greater than the time spent on discussion of renewables, renewable resources as a viewpoint was present in the majority of activities and student pages which focused on the resource base issue (see Table 9). It was concluded that the PEEC materials maintained a balanced perspective in their treatment of the resource base issue for future energy use.

In the overall treatment of the three controversial issues the PEEC materials did not consistantly present the viewpoints advocated by any one of the authors examined in the review of literature. It was therefore concluded that the PEEC materials presented a varied

perspective of the future energy use issue and were not biased toward any particular author's viewpoints.

Question 4

To what extent were the instructional materials consistent with recommended strategies for teaching energy-related subject matter? One strategy that was identified in the literature was the vertical integration of energy education in the schools. It was determined that the PEEC materials were intended for use in all grade levels from grades one through twelve. There was, however, a much heavier emphasis on the upper four grades, with a corresponding decrease in emphasis with decreasing grade levels (see Figure 3). Over half of the PEEC units were intended for use in grades nine and ten and/or grades eleven and twelve. Only three units were intended for use in grades one and two and/or grades three and four. It was concluded that while the PEEC units addressed all grade levels of pre-college education, the materials were heavily focused on the upper grades. It was also concluded that this lack of balance was not greatly significant due to two factors. The first factor was that most energy concepts have traditionally been taught at the secondary school level. The other factor that decreases the significance of this conclusion was that not

all students at the secondary school level would be exposed to all of the PEEC materials designed for use in the secondary schools. Units prepared for the subjects of chemistry, physics, and even biology would not be applicable to many secondary school students.

Another finding based on the reading level analysis was that the greatest amount of units (one third) tested out at the seventh or eighth grade reading levels. It was therefore concluded that the junior high or middle school would be the area of maximum usage for the PEEC materials in their present form.

Many authors expressed strong sentiments that energy education should gain exposure in all subject matter areas in the schools. The examination of the PEEC materials revealed that the materials were designed for six of the ten identified subject areas. Three of these six subject areas, english language arts, career development, and unified arts were represented in fewer than ten activities. Science and social studies, having more than five times the exposure of other subject areas, were by far the dominant subject areas in the PEEC materials (see Table 3). This lack of multidisciplinarity was concluded to be a major flaw in the PEEC materials. There was a noticeable absence of materials applicable to the areas of: business and distributive education; foreign languages; physical

education, health, and safety education; and vocational and technical education. There was also a very low emphasis on the additional areas of career development, english language arts, and unified arts. The PEEC materials were concluded to be primarily science and social studies units and contained evidence of little direction toward any other subject areas. This focus on two subject areas may have been a result of the composition of the writing teams that developed the PEEC materials.

Other recommended strategies for energy education included the use of three specific approaches: (a) the use of problem solving and decision making exercises, (b) the design of activities to make use of or apply to the students' local communities, and (c) the examination of students' attitudes and values in relation to energy. The analysis of the PEEC activities revealed that all three strategies were present in the materials. The most evident strategy was the problem solving/ decision making approach, which was present in two thirds of the units (see Table 11). Almost half of the units presented activities that had local applications. Student attitudes and values were examined in one third of the units. It was concluded that the recommended teaching techniques from the literature

were adequately utilized as a whole in the PEEC units. The specific strategy of examining students' attitudes and values, however, was somewhat underemphasized in relation to the other two teaching strategies.

SUMMARY AND RECOMMENDATIONS

Summary

The National Science Teachers Association Project for an Energy Enriched Curriculum (PEEC) was producing a set of interdisciplinary materials in energy, the environment, and the economy for use in the precollege classroom. The materials consisted of units on general energy topics which were composed of sets of student activities. Though these materials represented the nation's most comprehensive effort to bring the energy theme into the classroom, the materials had not been evaluated en masse outside of the NSTA organization. This study attempted to correct that oversight by the analysis and evaluation of the PEEC materials.

Since no appropriate evaluation instrument existed an instrument was designed. The instrument was based upon the criteria for effective energy education as expressed by authors in the field. Two matrices were developed which contained five categories for analysis. The five categories were: (a) reading levels, (b) subject areas, (c) energy content areas, (d) treatment of controversial issues, and (e) recommended teaching strategies. The instrument tested out to be 86% reliable.

The PEEC units and activities were individually analyzed by use of the matrices, and the data gathered were used to evaluate the PEEC materials. Reading levels determined with the Fry Readability Scale were found to differ from those intended in two thirds of the units. Discrepencies ranged from three grade levels below to four grade levels above the intended levels. The majority of the units were intended for use in the secondary schools, while the reading levels indicated that the junior high schools could benefit most by using the materials. The materials were directed toward use in the science and social studies classrooms and were determined not to be truely multidisciplinary. The materials made use of recommended teaching strategies; however, examination of students' attitudes and values toward energy was an underemphasized teaching strategy.

The PEEC materials addressed all identified energy content areas, but not enough exposure was given to the areas of energy conservation, physical laws, and energy strategies. While the materials dealing with future energy issues were found to be somewhat biased toward centralized energy systems and more biased toward the conservationist point of view, the materials were not consistently biased toward any particular energy future philosophy.

Recommendations

The following recommendations were made for the improvement of the PEEC materials, PEEC project, and the evaluation instrument. Recommendations were also made for further study.

Recommendations as a Result of the Data Analysis

1. The reading levels of the PEEC units should be adjusted to correspond to the grade levels for their intended use.

2. Reading levels of future PEEC units should be evaluated prior to publication of the units.

3. More activities should be developed that focus on energy conservation.

4. More activities should be developed that address the content areas of physical laws relating to energy and current energy supplies.

5. Activities should be developed that expose students to the growth perspective of the future energy use issue.

6. Future PEEC units should be directed toward subject areas in addition to science and social studies.

7. More units should be developed for use in the elementary schools, especially the primary schools.

8. More activities should be developed that examine students' attitudes and values toward energy.

Suggestions for Improving the PEEC Project

9. The PEEC materials should be periodically updated as new developments add additional perspectives to the energy situation and as the data in the units becomed outdated.

10. The PEEC activities should be made uniform in their use of units of energy, power, and work.

Recommendations for Further Study

11. The subcategories in the activity evaluation matrix should be more clearly defined in order to increase the reliability of the instrument.

12. The content areas of: (a) economy, politics, and society; (b) transformations, use, and efficiency; and (c) ecosystem interactions should be subdivided in order to more precisely caterorize the energy topic content of the activities.

13. Other energy education materials should be evaluated, especially those that are related to subject areas other than science and social studies.

14. A more thorough evaluation of the treatment of controversial issues should be undertaken which assesses the intensity of commitment to particular viewpoints that is present in the activities.

15. The PEEC materials should be evaluated to assess the underlying philosophical assumptions about energy which form the basis of the units.

16. The PEEC materials should be analyzed in order to determine the cognitive and affective levels to which the activities were directed.

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APPENDIX A

FREE CLASSROOM MATERIALS ON ENERGY

Through its Project for an Energy-Enriched Curriculum, sponsored by the U.S. Department of Energy, the National Science Teachers Association has produced a series of energy instructional packets for elementary and secondary schools. Written by social studies and science teachers, these materials are designed for convenient infusion into the existing curriculum. They feature a wide range of activities which encourage direct student participation while introducing basic energy concepts.

Of the total of twenty-four instructional packets, fifteen are now available in final form for classroom use. The nine packets produced during the summer of 1978 are now available in draft form for testing and evaluation. The fifteen packets described below are available free from:

U.S. Department of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, Tennessee 37830

Please use the Stock Number, where indicated, when ordering.

AVAILABLE IN FINAL FORM

Packet No.

1 How a Bill Becomes a Law to Conserve Energy
Grades 9, 11, 12

Activities focus on the legislative process and include a fabricated Citizen's Band (C.B.) radio conversation, a simulated congressional hearing on the 55 MPH speed limit bill, adapted from the actual hearing record, and exercises in graph construction and interpretation.
Stock No. EDM-1033.

2 Agriculture, Energy, and Society
Grades 10-12

Based on the conviction that an energy/food production crisis of serious dimensions is already with us, and that students need to understand this problem in order to contribute to its solution. Lessons present basic energy-economics facts of food production and social studies themes such as profit and loss, and the law of diminishing returns. Science lessons build skills in data analysis graph interpretation, and an understanding of energy units and their conversions.
Stock No. EDM-1034.

3 Energy, Engines, and the Industrial Revolution
Grades 8-9

A natural theme at the junior high level where the Industrial Revolution is an important topic in U.S. History and World Geography courses. The social studies lessons focus on the relation of energy sources to the growth of cities and industry, inventors and inventions, and the effects of the Industrial Revolution on cities and people. Science lessons are concerned with energy sources and energy conversions, with special attention given to the heat engine.
Stock No. EDM-1032.

Source: National Science Teachers Association

Packet No.

4 Transportation and the City
Grades 8-9

Relates transportation to energy use. Social studies lessons deal with transportation systems and concepts of efficiency, and with the effects of the automobile on the urban community. Science lessons apply supply and demand calculations to oil resources and present some simple experiments which anticipate new transportation technology.
Stock No. EDM-1031.

5 Community Workers and the Energy They Use
Grades 2-3

This unit highlights "helpers" such as the oil deliverer, the gas station attendant, and the meter reader, who are all involved in the delivery of energy, as well as the farmer and the banker, whose jobs are closely linked to energy.
Stock No. EDM-1030.

6 The Energy We Use
Grades K-2

An introduction to energy that begins with student recognition of common energy forms, and progresses through important energy sources such as the sun, wind, water, and fossil fuels.
Stock No. EDM-1029.

7 Energy and Transportation
Grades 3, 4, 5

Using classification activities, picture studies, and other developmental approaches, students learn about transportation in the neighborhood, community, and nation.
Stock No. HCP/U 3841-001.

8 Mathematics in Energy
Grades 7, 8

Middle school students deal with a wide range of energy problems through the use of basic mathematical processes. Included are fractions, decimals, graphs, conversions, statistics, and the manipulation of energy units such as watts, calories, and joules.
Stock No. HCP/U 3841-002.

9 U.S. Energy Policy - Which Direction?
Grades 11, 12

Designed as a companion to the unit "How a Bill Becomes a Law to Conserve Energy," which studies the workings of the legislative branch, this unit concentrates on the administrative arm of government and the various forces that go into formulating a national policy.
Stock No. HCP/U 3841-003.

Packet No.

10 Energy Transitions in United States History
Grades 8, 9

Charts the growth of American energy use and traces the history of the major sources of energy in the U.S. Examines the past interactions between man as an energy user, and his environment, and investigates the future of alternative energy technologies.
Stock No. HCP/U 3841-004.

11 Networks: How Energy Links People, Goods, and Services
Grades 4, 5

Lessons include making models of electrical systems and naming the interacting parts. In such lessons as "The Electrical Energy System in a City," students learn about the importance of systems and how we depend on the electrical systems in our community.

12 Bringing Energy to the People: Ghana and the U.S.
Grades 6, 7

Comparing the energy uses in Ghana and its capital city, Accra, with the Washington, D.C. metropolitan area, this unit considers energy as a basic need in terms of climate, location, existing and planned power sources, transportation systems, and life styles.

13 Energy in the Global Marketplace
Grades 9, 10, 11

Explores the role of energy in world trade and in the global balance of power. Examines the major energy "haves" and "have-nots," and investigates the process by which energy prices are determined.

14 Two Energy Gulfs
Grades 6, 7

A comparative case study of the energy potentials in the Gulf of Mexico and the Persian Gulf. Considers geography, geology, climate, and production technology, as well as the effects of oil production on the cultures of the two regions.

15 The New Westward Movement
Grade 11

Investigates energy resources in the West and studies the effects of possible large-scale resource development on the economy, environment, and social structure of the Western United States.

DRAFT PACKETS AVAILABLE IN TEST FORM

The following packets are available, free of charge, for review and classroom testing from:

National Science Teachers Association
1742 Connecticut Avenue, N.W.
Washington, D.C. 20009

Packet No.

16 There is Enough Energy, But...
High School Chemistry, Physics

This packet develops the concept of energy quality or usefulness. The student will become aware of the relationship of the application of the Second Law of Thermodynamics to energy. Energy forms and sources can be rated on an entropy scale. The increase of entropy (decrease of usefulness) will be treated through a series of energy conversions as well as matching usefulness to task. The meaning of "Second Law Efficiency" will be presented through examples.

18 Nuclear Energy
High School Physics, Chemistry, Biology, American Studies

This packet helps students understand the technical and scientific basis for nuclear power plants. The packet will also examine the political, economic, and social issues involved in the nuclear power controversy.

19 Solar Energy
Junior High/Intermediate Science

This packet investigates solar radiation as a source of energy and the amount of solar energy and its distribution. It describes fusion, solar cells, solar experiments. Other lessons are appropriate for art and literature classes.

20 Bioconversion
High School Biology and Chemistry

Students investigate how plant and organic matter can provide energy. Topics in biology can be addressed through photosynthesis, the comparison of various plants as energy sources, and the possibilities of genetic transformations of plants to improve their photosynthetic efficiency. Topics in chemistry are addressed not only through the photosynthetic reactions, but also through a study of some of the conversion methods (methane generation, pyrolysis, etc.).

22 Coal
Junior High/Upper Elementary Earth Science, Geology, Chemistry
Environmental Studies

This packet focuses on the formation and constitution of coal as well as the technological, environmental, and economic aspects of coal extraction, transportation, and use. The chemical and physiological aspects of pollution are discussed along with the chemical, physical, and economic aspects of pollutant removal.

Packet No.

23 Energy for the Future
High School Physics

Various projections of energy needs of this country are analyzed. The depletable energy resouces (fuels) are quantified and the various new technologies which can expand and diversify the contribution of depletable resources and open up new and renewable resources are described.

24 Energy and Water
High School General Science, Environmental Science, Social Studies

This unit emphasizes the finiteness of the closed hydrological cycle, as well as the energy needed in this system. The social studies component focuses on the tradeoffs between water for energy and for agriculture, industry, urbanization, recreation, etc. The science component investigates water for cooling, thermal pollution, water for coal gasification, oil shale retorting, coal slurry transportation.

25 Energy and Money
High School Economics, American Studies, Mathematics

The relationship between the projected increase in demand for energy and the need for investment is discussed. The capital needs of different energy technologies are investigated. The importance of profit to attract investment, and the effects on the energy situation of the rising cost and potential shortage of capital are dealt with.

26 Exponential Growth
Intermediate/Junior High Social Studies, Mathematics, Science

This unit looks at energy uses and energy resources through the vehicle of the exponential growth curve. In order to understand the consequences related to energy consumption and population growth, students deal with very large numbers. Activities on exponential growth, doubling time, graphing statistical data, and finiteness are highlighted. Growth in relation to the quality of life is examined in several of the lessons.

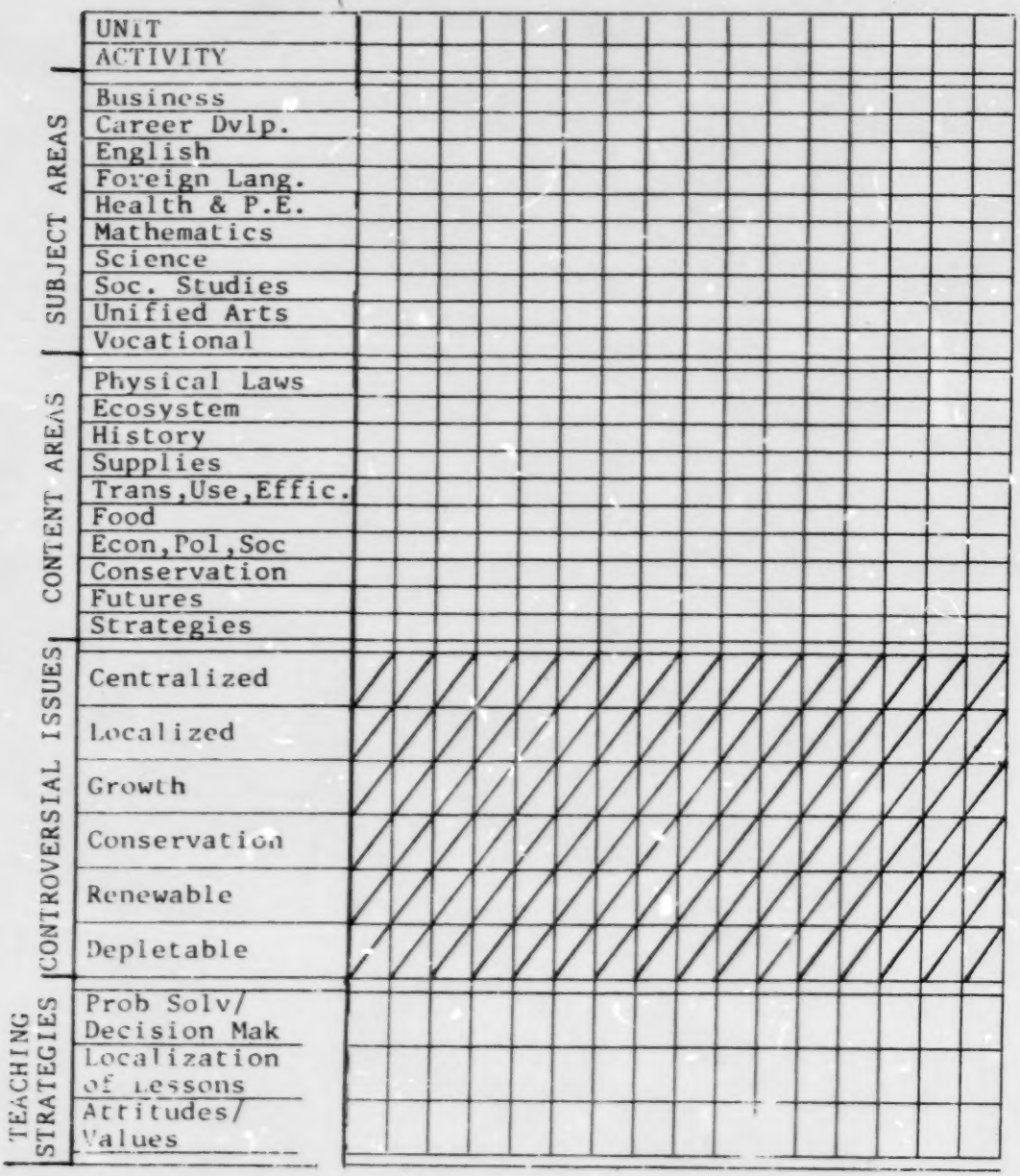
APPENDIX B

FRY READABILITY ANALYSIS

Unit	Pages	Sentences	Syllables	Level Calculated	Level Specified

APPENDIX C

ACTIVITY EVALUATION MATRIX



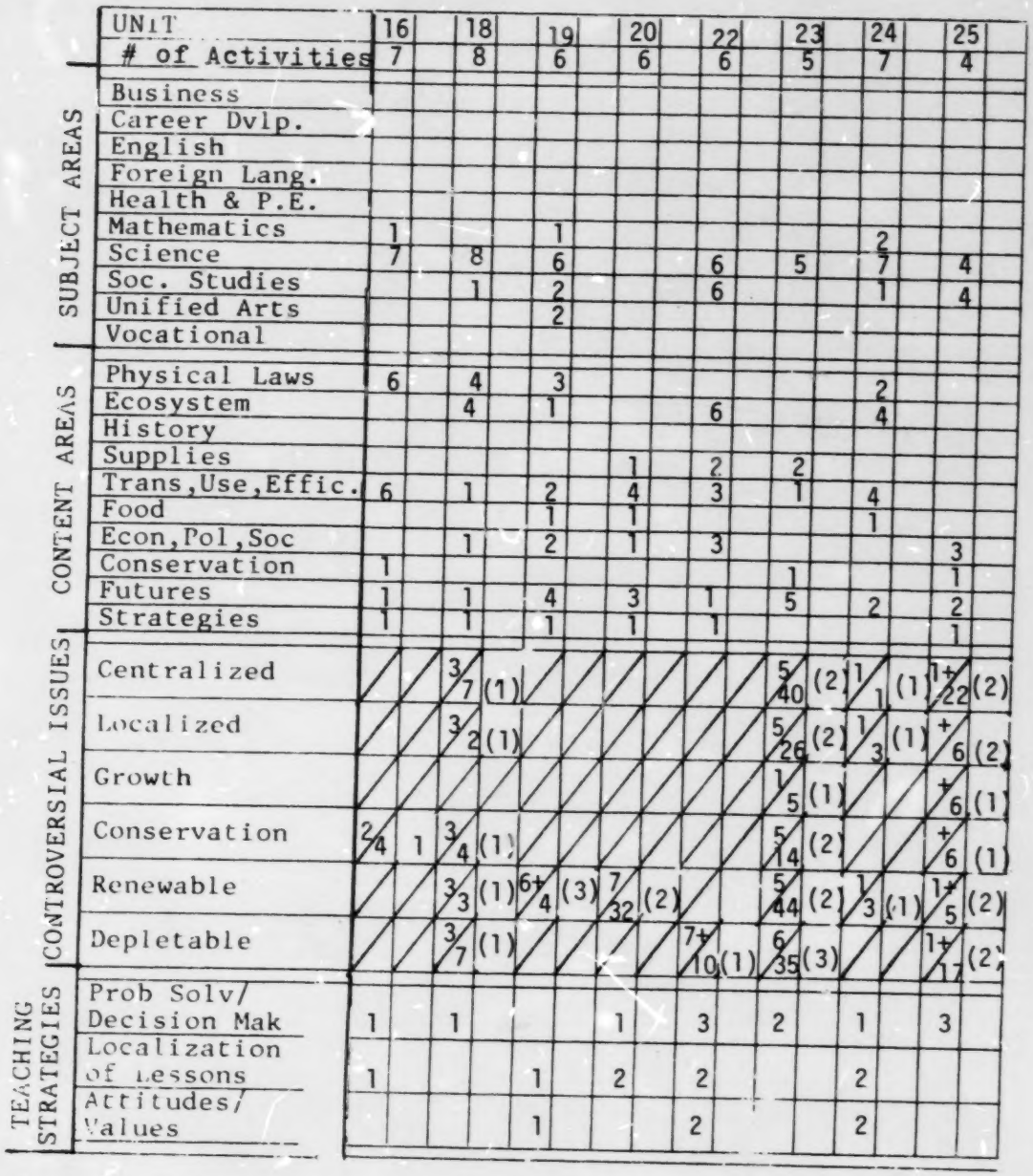
APPENDIX D

	UNIT	1	2	3	4	5	6	7	8
	# of Activities	7	11	5	4	13	9	7	5
SUBJECT AREAS	Business								
	Career Dvlp.		2			Not Applicable	Not Applicable	Not Applicable	
	English		1						
	Foreign Lang.								
	Health & P.E.								
	Mathematics	1	1						5
	Science	2	7	2					
	Soc. Studies	5	11	3	4				3
	Unified Arts		2						2
	Vocational								
CONTENT AREAS	Physical Laws			1		1	1		
	Ecosystem	1			1			1	1
	History		2	3	1				1
	Supplies					1	4		
	Trans,Use,Effic.			3	1	6	5	4	5
	Food		11			3	3		1
	Econ,Pol,Soc	5	1	2	4	7		2	4
	Conservation	6			1	3	1		2
	Futures		1				1	1	1
	Strategies								
CONTROVERSIAL ISSUES	Centralized								
	Localized								
	Growth								
	Conservation								
	Renewable		1/3 (1)				+ (1)		
	Depletable		1/3 (1)						
TEACHING STRATEGIES	Prob Solv/ Decision Mak				2	1		2	
	Localization of Lessons		1		1	10			
	Attitudes/ Values	1	1	1	1				

( ) indicates # activities in unit dealing with issue

\+ indicates activity without specified time limit

	UNIT	9		10		11		12		13								
	# of Activities	6		3		6		4		5								
SUBJECT AREAS	Business																	
	Career Dvlp.																	
	English																	
	Foreign Lang.																	
	Health & P.E.																	
	Mathematics			2														
	Science	3		3		4		1										
	Soc. Studies	6		3		4		4		5								
	Unified Arts																	
	Vocational																	
CONTENT AREAS	Physical Laws					1												
	Ecosystem			1		1												
	History	1		3				1										
	Supplies	1		1		1				2								
	Trans,Use,Effic.			2		5		3		1								
	Food																	
	Econ,Pol,Soc	3		1		2		1		4								
	Conservation					1												
	Futures	3																
	Strategies	2																
CONTROVERSIAL ISSUES	Centralized																	
	Localized																	
	Growth																	
	Conservation																	
	Renewable																	
	Depletable	3/9	(1)															
TEACHING STRATEGIES	Prob Solv/ Decision Mak	1		2		3												
	Localization of Lessons					1												
	Attitudes/ Values																	



	UNIT	16	18	19	20	22	23	24	25
	# of Activities	7	8	6	6	6	5	7	4
SUBJECT AREAS	Business								
	Career Dvlp.								
	English								
	Foreign Lang.								
	Health & P.E.								
	Mathematics	1		1				2	
	Science	7	8	6		6	5	7	4
	Soc. Studies		1	2		6		1	4
	Unified Arts			2					
	Vocational								
CONTENT AREAS	Physical Laws	6	4	3				2	
	Ecosystem		4	1		6		4	
	History								
	Supplies				1	2	2		
	Trans,Use,Effic.	6	1	2	4	3	1	4	
	Food			1	1			1	
	Econ,Pol,Soc		1	2	1	3			3
	Conservation	1					1		1
	Futures	1	1	4	3	1	5	2	2
	Strategies	1	1	1	1	1			1
CONTROVERSIAL ISSUES	Centralized		3/7 (1)				5/40 (2)	1/1 (1)	1+/22 (2)
	Localized		3/2 (1)				5/26 (2)	1/3 (1)	+/6 (2)
	Growth						1/5 (1)		+/6 (1)
	Conservation	2/4 1	3/4 (1)				5/14 (2)		+/6 (1)
	Renewable		3/3 (1)	6+/4 (3)	7/32 (2)		5/44 (2)	1/3 (1)	1+/5 (2)
	Depletable		3/7 (1)			7+/10 (1)	6/35 (3)		1+/17 (2)
TEACHING STRATEGIES	Prob Solv/ Decision Mak	1	1		1	3	2	1	3
	Localization of Lessons	1		1	2	2		2	
	Attitudes/ Values			1		2		2	

APPENDIX E

FRY READABILITY ANALYSIS

Unit	Pages	Sentences	Syllables	Level Calculated	Level Specified
1	77	8.0	129		
	91	5.5	179		
	115	10.5	143		
	avg.	8.0	150	8	9,10,11
2	73	9.4	157		
	75	5.6	181		
	79	5.4	166		
	avg.	6.8	168	12	10,11,12
3	49	6.2	141		
	55	7.9	152		
	59	7.8	153		
	avg.	7.3	149	8	8,9
4	32	7.1	169		
	38	5.5	188		
	37	6.0	159		
	avg.	6.2	172	college	8,9
5	NA	NA	NA	NA	2
6	NA	NA	NA	NA	1
7	10	10.6	124		
	79	9.5	128		
	86	11.7	127		
	avg.	10.6	126	3	3
8	75	8.5	134		
	82	7.5	146		
	89	9.6	147		
	avg.	8.5	142	7	8,9
9	76	6.0	155		
	87	4.9	196		
	56	5.4	142		
	avg.	5.4	164	12	11,12
10	69	7.1	133		
	85	6.9	130		
	72	9.3	126		
	avg.	7.7	129	5	8,9
11	79	7.0	157		
	76	9.0	146		
	94	11.2	145		
	avg.	9.0	149	7	4,5
12	58	11.8	126		
	47	9.0	126		
	48	12.5	139		
	avg.	11.1	130	3	6,7

FRY READABILITY ANALYSIS

Unit	Pages	Sentences	Syllables	Level Calculated	Level Specified
13	55 51 62 avg.	9.0 6.5 5.5 7.0	126 160 152 150	8	9,10,11
14					
15					
16	60 37 24 avg.	8.8 5.7 4.9 6.5	166 184 175 175	college	10,11,12
18	81 144 119 avg.	6.1 5.5 8.9 6.8	150 170 121 147	8	11,12
19	33 33 55 avg.	13.1 13.1 9.1 11.8	150 150 129 143	5	6,7,8
20	76 84 155 avg.	4.3 5.7 8.4 6.1	164 176 174 171	college	9,10,11,12
22	31 80 15 avg.	13.0 8.0 5.8 8.9	142 152 162 152	7	6,7,8
23	88 95 51 avg	5.2 3.1 5.3 4.5	163 150 184 166	college	10,11,12
24	129 85 81 avg.	4.9 8.0 5.0 6.0	157 157 156 157	10	9,10,11,12
25	16 25 39 avg.	7.6 6.6 7.2 7.1	165 172 187 175	no level available	10,11,12